

Assessment of ICTs in Classroom Instruction

Purpose

The purpose of this research project was to analyze assessment tools used for evaluation of technology in STEM classroom teaching. The analysis of assessment tools was outgrowth of a professional development project provided through the Title II2 Digital Immigration Project-Phase II designed to increase teachers' knowledge and skills for using technology for teaching Science, Technology, Engineering, and Mathematics (STEM) content in low performing middle schools and high schools in Districts 9 and 10 of the Bronx borough of New York City. This project involved analysis of the classroom observation instrument adopted for the project and examination of other instruments that included more detailed assessment of classroom implementation of technology.

The professional development activities included graduate courses, continuing education and non-credit professional development offerings. The New York Institute of Technology instructional technology graduate courses addressed research-based practices focused STEM topics correlated to grade level content standards. The non-credit professional development courses, seminars and workshops were provided by informal science institutions such as the Liberty Science Museum, New York Hall of Science and Bronx Zoo. Much of the professional development included video conferencing bringing programs to the classrooms to supplement the classroom teachers' STEM content knowledge. Additionally push-in technical support was provided to assist in implementing the technology in the classroom setting. The Digital Immigration Project objectives are to: 1) prepare teachers to use technology in STEM teaching

and learning, 2) increase participants' knowledge in STEM content, 3) provide instructional strategies for teaching STEM in middle school and high school environments, and 4) assess the extent of use of ICTs in STEM classrooms. All the professional development offerings focused on math, science and technology integration and technology applications of 21st Century Skills, i.e. skills areas of critical thinking, problem solving and information communication technology literacy.

The purpose of this paper is to share the results of the analysis of the technology assessment instruments considered for evaluating use of ICTs in classrooms. The objectives are 1) to determine the validity of the instruments aligned with standards, 2) to examine the alignment of assessment and professional development, 3) to identify how the assessment results can be used to improve the professional development, 4) to recommend tools and strategies for assessing effective uses of ICTs in instructional settings.

Perspective/Theoretical Framework

The Partnership for 21st Century Skills (<http://www.21stcenturyskills.org/>) has identified 21st Century Skills critical to strengthening American education. The premise of the 21st Century Skills is based on John Dewey's philosophy that education should develop the child's 'social power and insight' (Dewey, 1980). The mantra for *learning by doing*, and a curriculum that involves the *mind, hands and heart* reflect the essence of Dewey and his influence on the foundation of the Partnership for 21st Century Skills.

The Partnership for 21st Century Skills addresses the learning needs of the 21st century according to three themes: education and society, education and learning sciences, and education and learning tools. Society is now operating in an information age with the personal computer and Internet integral to virtually every sector of the world economy. A global workforce is leveraging high-speed communications, thereby creating new labor sources. In 1991 the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS) addressed the workplace skills needed in the 21st century, and how American schools are preparing students for these skills. The conclusions were that the needs of the workforce require more proficiency in information age skills than industrial age. That is, critical thinking, problem solving, communication and collaboration.

In the 20th century we have amassed a wealth of information about how people learn. Vygotsky (1978) demonstrated the importance of learning in a social environment, Piaget (1928) provided the rationale that learning occurs through sequential processing known as constructivism, and Bloom (1956) formulated a hierarchy of cognitive skills as taxonomy for critical thinking. The Partnership for 21st Century Skills calls for including these advances in cognitive sciences in our instructional practices.

Technology links the skills needed for entering the global workforce and how people learn. The media, telecommunications and high-speed broadband networks make global communication available for all. Students can now connect with global experts and peers. They can focus on higher order thinking, collaboration, and innovation in ways never before possible in schools.

The Partnership for 21st Century Skills organized student outcomes into the following major categories:

- Core subjects and Interdisciplinary themes
- Learning and Innovative Skills
- Information, Media and Technology Skills
- Life and Career Skills

In order for students to achieve 21st century skills 21st century standards, assessment, curriculum, instruction, and professional development should be aligned. The Route 21 website designed by the Partnership for 21st Century Skills provides skills-related information, resources and community tools to facilitate the alignment for educators. The Assessment portion of Route 21 is a database of 110 formative and summative 21st Century Skills assessments. The accompanying search engine can be used to identify formative or summative assessments in skill areas for information, media and technology skills, learning and innovative skills, and knowledge areas of core subjects and interdisciplinary themes. These assessments can be useful to educators for assessing students' competencies in 21st century skills resulting from professional development and instructional practice.

The evaluators of the Digital Immigration II project adopted a classroom observation tool called Reformed Teaching Observation Protocol (RTOP) developed, validated, and distributed by Arizona State University. The protocol is organized around these constructs: Contextual Background of Lesson, Lesson Design and Implementation, Content, and Classroom Culture. The observers use a Likert scale to record the presence of specific elements of instruction under

each of these areas. Lacking in the protocol are metrics for assessing uses of technology in the classroom instruction. However the probes provide valuable information regarding instructional strategies and classroom environment.

The International Society for Technology in Education (ISTE) released revised National Education Technology Standards (NETS) for Teachers at the National Educators Computer Conference in 2008. These standards address classroom teaching practices for designing, implementing, and assessing student learning, engagement, and improvement. Also in 2008 ISTE released a Classroom Observation Tool (ICOT), supported by Hewlett-Packard Company, to guide classroom observations of technology integration. The tool includes queries such as 1) the characteristics of the learning environment and students, 2) the teacher's actions, (i.e. lecturing, discussion, interactive directions, etc.), 3) the student learning activities (i.e. creating presentations, researching, writing, drill and practice, etc.) 4) the technologies used by teacher and by students, 5) a time interval chart of technology use by teacher, student and for learning, and 6) and the teacher standards addressed.

Evaluators of Title IIB professional development grants have developed technology use inventories to focus on the technology use, NETS standards addressed with specific target content areas, such as STEM, in under-achieving schools. These tools are basically check lists of availability of specific technologies and teachers' comfort level for using what is available. The evaluation of effective technology implementation is not adequately addressed. The correlation of professional development evaluation and student achievement cannot be considered as valid cause-and-effect for student learning. However analysis is useful to evaluate multiple

instruments that pinpoint factors to consider in improving professional development that may affect improvement in instructional practices.

Yet another assessment tool that could be used is an e-portfolio. Teachers use K-12 student work samples as evidence of effective technology applications for teaching and learning. They align instructional activities with state standards and performance indicators and plan the instruction and assessment to determine the students' achievement of the standards. Rubrics are designed and applied for evaluation of the student work, thereby providing evidence of effective uses of technology in the classroom. This type of teacher-developed artifacts can be an important factor in assessing implementation of technology in the classroom. However e-portfolios do not lend themselves to real-time observation of instruction, but rather more summative evidence of instructional outcomes.

Research Methods

The methodology consisted of a review of various assessment instruments available through the RTOP, locally developed technology use inventories, Partnership for 21st Century Schools Route 21, and the ISTE Classroom Observation Tool. The assessment instruments were compared for validity and feasibility for implementation in the classroom. The research questions are: 1) how can classroom observation tools can be used to evaluate technology use in the classroom, and 2) how are classroom assessment tools aligned with the professional development (graduate and non-credit) course content in syllabi. Analysis of the instruments consisted of comparable factors, observable actions, and access to technologies; professional development for use, application, and evaluation of technology for specific content areas/students.

Results

The results will inform the design, or adoption, of a technology assessment instrument(s) appropriate for the professional development curriculum and instructional environment of the participants. The instruments reviewed vary in specificity to provide adequate quantitative information for assessing uses of technology for instruction in STEM classrooms. Qualitative information of teacher knowledge and skills, students' characteristics, and conditions for implementation of technology in instruction are needed as context for the observation and assessments.

Classroom observations were conducted in ten classrooms ranging from K-10, using the RTOP protocol for classroom observation for teacher preparation for science education. A section of the protocol included space for a narrative description of Contextual Background and Activities. The observer recorded the technology configurations available in the space provided and drew diagrams for furniture arrangements. Another area of the form provided space to describe the events observed to help document the rating indicated on the Likert scale. A summary of the technology available by grade level recorded in the open-ended questions is below:

Grade	Technology Available	Technology Barriers or Needed
K	Computer lab wiki	SmartBoard, projector Filter blocked animal sounds
3 Sp Ed	Laptop cart/projector website with video	Directions in unison
3	Smartboards, webquests, laptops	Pop-ups , Search skills
5 Inclusion	Smartboard and Video on Internet	Calibration of Smartboard Computer freezing
6	LCD projector, laptop, PowerPoint	No access to own laptop

7	Smartboard, laptops, overhead projector, flash video	Video conferencing
7/8 Sp Ed	Laptops on cart Google Images	Hands-on – image as model
9	Pasco Probes/ Graphing Laptop, Smart Board, TI 83s, projector	Computers to use with probes and calculators
10	Teacher station projector PowerPoint with Internet	Note taking

The data indicate that the ability to use technology as an indicator of the effectiveness of the professional development is extremely limited by the actual classroom environment, student population, classroom management practice, and technology available. The data are too limited to reveal patterns of implementation related to professional development under the various parameters of grade level, class size, and technology accessibility and configuration. However, this limited sample indicates that regular access to technology for preparation of instruction, access to the internet, and reliable equipment in addition to extensive professional development is necessary to support effective classroom implementation.

A technology inventory was administered to obtain more in-depth information regarding the technology in these schools. As part of the evaluation, one administrator from each target and comparison school was asked to provide information about the types of technologies, laboratory equipment and partnerships available to support their school’s math, science, and technology programs. The data collected through this online inventory is intended to serve as a baseline measure of students’ and teachers’ access to technology resources and lab equipment in each school. Seven target schools and seven comparison schools completed this online inventory (N=14 total responses). The results show that:

- Similar proportions of teachers had access to the following technologies for classroom use: desktop and/or laptop computers with internet access, SmartBoards, scanners, televisions, VCRs/DVD players, overhead and LCD projectors, printers, cameras, video cameras and math/science-related educational software. More target schools than comparison schools, however, reported that teachers had access to ELMOs and web-based science simulations.
- Similar proportions indicated that teachers had access to the following laboratory equipment for classroom use: calculators and thermometers, water supply, scales/balances, graduated cylinders/flasks/beakers, microscopes, specimens, tuning forks, mirrors and lenses, directional compasses, magnets, topographic maps, dissection materials, stains/indicators and prisms.
- More target schools than comparison schools had access to experts in science, math and/or engineering through partnerships with local universities or informal science institutions.
- More comparison school administrators than target school administrators felt that teachers in difficulty integrating technology into their math or science instruction were due to the following: teachers' level of technology skill and knowledge and skill and knowledge about integrating technology with content, and lack of time to explore resources and appropriate uses of technology.

Finding a lack of specificity in the result of RTOP and the locally developed technology inventory, other sources for technology assessment were reviewed. Route 21 is a resource to support Partnership for 21st Century Skills organized around support systems such as standards,

assessments and professional development, curriculum and instruction and learning environments; skill areas including information, media and technology skills, learning and innovative skills, and life and career skills; and knowledge areas of core content and interdisciplinary themes. A search of the site produces 54 formative and 83 summative assessments. A review of these assessments indicates that some are state specific, others are content specific, and still others are general skills. When reviewing details many assessments are embedded in a curriculum and some are commercial with associated fees for use. Route 21 could be a valuable starting point for locating assessment tools but requires an intensive review for finding tools appropriate for the context of the assessment. Once a tool is selected there may be associated costs for use and administering the assessment.

Another tool for observation is the ISTE Classroom Observation Tool (ICOT). The ICOT protocol includes contextual descriptions using check lists and comment areas for student characteristics, groupings, teacher's role, learning activities, and a ranking of the whether technology was essential in the teaching and learning activities. Questions addressed the technology used by the teacher and by the student during the observation. The tool includes a checklist of the NETS Teacher Standards and sub-categories. The last component of the classroom observation is an interval chart to determine the time technology is in use by the student, teacher, and for learning (as opposed to recreation and time spent in routine tasks of operating the technology).

Educational and/or Scientific Importance

This research informs the design and development (or adoption) of appropriate classroom observation metrics assessing implementation of ICTs in classrooms, specifically in STEM instruction. The RTOP protocol lacked specificity in assessing effective uses of technology but rather relies on technology present in the classroom or reported by the teachers being observed. The technology inventory does not capture actual classroom use. In fact administrators were asked to complete the technology without directions to consult with teacher to gain their input into the report. Route 21 promises to be a comprehensive resource but requires intensive research and time to locate the most appropriate tools to consider for adoption. Some Route 21 Assessment Resources are content specific, or designed for a specific state, or district, and may be embedded in commercial curriculum which is not free. The ISTE ICOT protocol seems to combine the elements of collecting contextual descriptions, technology uses observed by teacher or student, evidence of standards addressed, observable technology inventory, and an interval probes for time technology is used. This tool holds great promise for capturing the essence of effective technology implementation. Data available from ICOT would be invaluable to professional developers, administrators, and teachers for planning future professional development for technology implementation in 21st century classrooms. Data using the ICOT assessment along with the teacher's reflection could paint a clear picture of effective technology use for teaching and learning.

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